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UNITED STATES PATENT APPLICATION

for

DIRECTLY LAMINATED TOUCH SENSITIVE SCREEN

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DIRECTLY LAMINATED TOUCH SENSITIVE SCREEN

FIELD OF THE INVENTION

This invention relates generally to touch screen displays, and more particularly to a touch screen directly laminated to a display.

BACKGROUND OF THE INVENTION

A touch screen is a user interface that covers a display and enables a user to operate a device simply by touching various locations on the touch screen. The touch screen is clear, so the user can view the display through the touch screen. The display shows information that enables a user to control the device by touching various locations on the touch screen. For example, the display may show various buttons that are associated with certain commands. When the user touches an area on the touch screen over the button, the device executes the command associated with that button. The device typically includes custom applications that enable the device to receive inputs from the touch screen. The touch screen may be sensitive to the touch of a finger, stylus, or other pointing device.

Touch screens typically include a laminate of at least two films with conducting internal surfaces and an array of spacers. Pressure on a surface of the touch screen decreases the resistance of the laminate at the point of pressure, thereby enabling the electronic detection of the location of the point of pressure. Thus, the location of a finger or stylus being used to touch the screen can be determined.

A touch screen may be used with display for a personal computer, such as a cathode ray tube (CRT) monitor. Additionally, a touch screen may be used with a portable device such as a laptop computer or a personal digital assistant (PDA). Laptop computers and PDAs typically utilize liquid crystal displays. Newer types of displays that may be used with PDAs and other portable electronic devices include organic light emitting diodes (OLEDs) and electronic ink.

LCDs require that a fixed amount of space be maintained between two glass plates that surround the shell of the liquid crystal. If pressure is applied to either of these plates, the image displayed on the LCD may be distorted. This phenomenon is typically referred to as bruising. Distortion of the image displayed on the LCD is detected around the area where pressure is applied. If sufficient pressure is applied to either of the glass plates, permanent damage to the cell may occur.

Because touch screens typically require an applied pressure to determine the location of a pointing device, and because LCDs are sensitive to applied pressure, a touch screen that is used with an LCD must be mounted on a separate piece of glass that is suspended some distance from the LCD. **Figure 1** illustrates a touch screen display 100 including a touch screen 102 suspended above an LCD 104 according to the prior art. Touch screen 102 includes a glass substrate 106, to which a touch screen system 108 is attached. Glass substrate 106 provides rigidity to touch screen 102. Touch screen system 108 may be laminated to the surface of glass substrate 106. LCD 104 includes a first glass plate 110 and a second glass

plate 112. A liquid crystal display element 114 is located between first glass plate 110 and second glass plate 112.

Since liquid crystal display element 112 is sensitive to pressure, an air gap 114 must be maintained between touch screen 100 and LCD 102. Glass substrate 106 prevents touch screen 102 from coming into contact with LCD 104 when pressure is applied to touch screen system 108. However, the presence of glass substrate 104 and air gap 114 results in increased weight and bulk of the device on which the display is used. Furthermore, glass substrate 104 may reduce optical performance due to increased reflections from internal surfaces.

SUMMARY OF THE INVENTION

A touch screen display having a touch screen directly coupled to a display is described herein. According to one embodiment of the present invention, the touch screen is laminated directly to the display. The display may be an interferometric modular display. Alternatively, the display can be any type of display that is not sensitive to pressure.

Additional features and advantages of the present invention will be apparent from the accompanying drawings and from the detailed description that follows.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example, and not by way of limitation, in the figures of the accompanying drawings and in which:

Figure 1 illustrates a touch screen display including a touch screen suspended above an LCD according to the prior art;

Figure 2 illustrates one embodiment of a touch screen display including a touch screen directly laminated to a display;

Figure 3 illustrates one embodiment of an iMoD display;

Figure 4 illustrates one embodiment of a touch screen display having a touch screen directly mounted to an iMoD;

Figure 5 illustrates another embodiment of a touch screen display having a touch screen directly mounted to an iMoD; and

Figure 6 illustrates another embodiment of a touch screen display having a touch screen directly mounted within an iMoD.

DETAILED DESCRIPTION OF THE INVENTION

In the following detailed description of embodiments of the invention, numerous specific details are set forth such as examples of specific materials, machines, and methods in order to provide a thorough understanding of the present invention. It will be apparent, however, to one skilled in the art that these specific details need not be employed to practice the present invention. In other instances, well known materials, machines, or methods have not been described in detail in order to avoid unnecessarily obscuring the present invention.

A touch screen coupled directly to a display is described herein. The display may be an interferometric modulator display (iMoD). Alternatively, the display may be a light emitting polymer (LEP) display, an organic light emitting diode display (OLED), an electronic ink display, or any other type of display that is not sensitive to pressure. The touch screen may be mounted or laminated directly to a glass plate on the display.

Figure 2 illustrates one embodiment of a touch screen display 200 including a touch screen 202 directly laminated to a display 204. Touch screen 202 is mounted or laminated directly to display 204 using conventional techniques. Display 204 includes a first glass plate 206 and a display element 208. Display 204 may also include a second glass plate 210. First glass plate 206 provides rigidity to display 204 and provides protection for display element 208. Second glass plate 210 may provide additional rigidity and protection to display 204.

Display element 208 may be an iMoD display, such as the iMoD display manufactured by Iridigm Display Corporation, located in San Francisco, California 94107. The iMoD display is not pressure sensitive, and therefore the image produced by the iMoD display is not

distorted when pressure is applied to its surface. **Figure 3** illustrates one embodiment of an iMoD display 300. iMoD display 300 includes a substrate 302 upon which one or more thin film stacks 304 are deposited. A metallic membrane 306 resides on substrate 302 such that each individual thin film stack 304, together with the portion of metallic membrane 306 covering the individual thin film stack 304, forms an iMoD 308. All of the iMoDs 308 in iMoD display 300 form an iMoD array 310. A seal 312 may be attached to substrate 302 so as to surround iMoD array 310. A packaging component 314 may be mounted on seal 312 such that packaging component 314 covers iMoD array 310. iMoD display 300 may also incorporate a front-surface element 316 or combination of front-surface elements, which may include diffuser films, gain films, front-lighting systems or other elements which serve enhance or modify the performance of iMoD display 300. iMoD array 310, in conjunction with substrate 302, seal 312, packaging component 314, and front-surface element 316 forms iMoD display 300.

The distance between thin film stack 304 and metallic membrane 306 in an iMoD 308 determines the color produced by the iMoD 314. The distance between thin film stack 304 and metallic membrane 306 is set during manufacturing to determine the color produced by the iMoD 308. iMoD array 310 may include iMoDs 308 having different distances between thin film stack 304 and metallic membrane 306, thus producing different colors. For example, an iMoD 318 having a first distance may produce red light, an iMoD 320 having a second distance may produce green light, and an iMoD 322 having a third distance may produce blue light. Multiple iMoDs 308 having the same distance, and therefore producing the same color,

may form a sub-pixel 324. By including multiple iMoDs 308 within a single sub-pixel 324, the yield of iMoD display 300 can be increased. Furthermore, multiple sub-pixels 324 may form a pixel 326. Pixel 326 may include sub-pixels 324 having iMoDs 308 that produce different colors. For example, pixel 326 may include a sub-pixel 328 producing red light, a sub-pixel 330 producing green light, and a sub-pixel 332 producing blue light. Thus, iMoD display 300 can show a color image.

iMoD displays are described in further detail in U.S. Patent 5,835,255, filed May 5, 1994; U.S. Patent 5,986,796, filed Nov. 5, 1996; U.S. Patent 6,040,937, filed Jul. 31, 1996; and, U.S. Patent 6,055,090, filed Jan. 27, 1999. The disclosures of each of the aforementioned patents are herein incorporated by reference.

Figure 4 illustrates one embodiment of a touch screen display 400 having a touch screen 402 directly mounted to an iMoD 404. Touch screen 402 is directly coupled to iMoD 404. In one embodiment, touch screen 402 is laminated directly to glass substrate 406. Touch screen 402 may be coupled directly to iMoD 404 because iMoD 404 is not sensitive to pressure. Thus, a user may apply pressure to touch screen 402 and iMoD 404 is not affected. In alternate embodiments, touch screen 402 is coupled to iMoD 404 using other conventionally known methods. **Figure 5** illustrates another embodiment of a touch screen display 500 having a touch screen 502 directly mounted to an iMoD 504. iMoD 504 includes a front-surface element 506 or combination of front-surface elements, which may include diffuser films, gain films, front-lighting systems or other elements which serve enhance or modify the performance of iMoD 504. Touch screen 502 is laminated directly to front-

surface element 506. **Figure 6** illustrates another embodiment of a touch screen display 600 having a touch screen 602 directly mounted within an iMoD 604. Touch screen 602 is directly mounted to substrate 606, and front surface element 608 resides on touch screen 602. In alternative embodiments, touch screen 602 can reside anywhere in the layers of components that reside on substrate 606.

A touch screen may be directly coupled to any other type of display that is not sensitive to pressure. In one embodiment, the touch screen may be directly coupled to a light emitting polymer (LEP) display, such as the LEP display manufactured by Seiko Epson Corporation and Cambridge Display Technology, located in Seattle, Washington 98101 and Cambridge, United Kingdom, respectively. In another embodiment, the touch screen may be coupled directly to an organic light emitting diode (OLED) display, such as the OLED display manufactured by Sanyo Electric Co. and Eastman Kodak Company, located in Compton, California 90220 and Rochester, New York 14650, respectively. In another embodiment, the touch screen may be directly coupled to an electronic ink display such as the eInK display manufactured by Gyricon Media Inc., located in Stamford, Connecticut 06902. Touch screen displays including other types of displays that are not sensitive to pressure are intended to be include within the scope of the present invention.

In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made thereto without departing from the broader spirit and

scope of the invention as set forth in the appended claims. The specification and drawings are, accordingly, to be regarded in an illustrative rather than a restrictive sense.